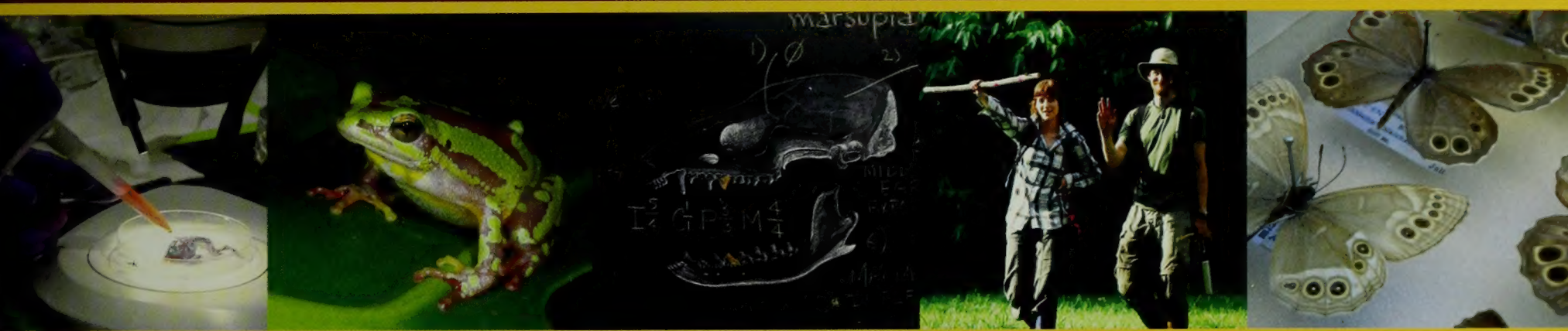


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MUSEUM OF COMPARATIVE  
**ZOOLOGY**  
ANNUAL REPORT  
HARVARD UNIVERSITY



2009–2010







# DIRECTOR'S MESSAGE

This was a year of important transitions for the MCZ. We bid a lasting farewell to two dear friends and colleagues and welcomed several new ones. We celebrated our 150<sup>th</sup> anniversary and launched new research endeavors. We dusted off old specimens and are making room for vital new collections. This report reveals the MCZ as a dynamic and evolving institution.

In September 2009, Dr. Karel Liem, Henry Bryant Bigelow Professor of Ichthyology and Curator of Ichthyology, succumbed to cancer. A memorial gathering the following December celebrated Karel's life and work in an event filled with gratitude, memories and laughter.

In April 2010, we lost another important member of our community, Mr. David Stone. A longtime member of the MCZ Faculty, the MCZ's governing board, David was a champion of environmental education and natural history. His wisdom and personal warmth, as well as his passionate advocacy on behalf of the MCZ, will be missed tremendously. Toward the end of his tenure on the Faculty, David was keen that we recruit new members to this prestigious group. In that spirit I am delighted to introduce three new members later in this report. I'm looking forward to working with them to serve the MCZ in the best way possible.

In January, Charles Marshall, MCZ's Curator of Invertebrate Paleontology, left Harvard to assume the directorship of the University of California Museum of Paleontology. Charles's departure was a loss for the MCZ, but we wish him success in his new position.

The MCZ is beginning to make its mark on Harvard's new Northwest Building. Two whale skeletons were hauled out of our attic and, after a thorough cleaning and minor repairs, installed in the main lobby last January. Soon, the MCZ will begin relocating into the building all or portions of eight research collections. These specimens will be housed in a new state-of-the-art collections facility intended for faculty, students and visiting scientists.

The MCZ is not immune to problems posed by the recent economic downturn, yet thanks to robust financial strategies implemented well before I became director, we maintain our ability to pursue ambitious programs of intellectual inquiry, formal and informal science education, professional training, and collections development and stewardship focused on biodiversity and comparative biology.

The ongoing accomplishments of MCZ's faculty-curators and associated personnel testify to their willingness to incorporate new technologies and advances in molecular biology and genomics, functional biology, biodiversity informatics and digital imaging.

We maintain worldwide collaborations through our participation in the Encyclopedia of Life, the Biodiversity Heritage Library, Assembling the Tree of Life and other global biodiversity initiatives, and we look forward to launching new ones.

To ensure the success and ongoing impact of the institution, we continue to invest significant energy and resources to train new generations of scientists through a variety of specimen-based courses and in-house grant programs.

As always, I am deeply appreciative of everyone associated with the MCZ who made this year a success. I look forward to joining them carry the momentum and enthusiasm into next year.

James Hanken  
*Director*



Catherine Weisel

*Cover photo credits:*

*Top, left to right: Jonathan Woodward, Joanna Larson, illustration by Farish A. Jenkins, Jr., Gabriel Miller, Paul Morris*

*Bottom, left to right: Clemens Küpper, Daniel DenDanto, Gonzalo Giribet, Jon Sanders, Jonathan Ruel*

*Opposite page photo credit: Daniel DenDanto*





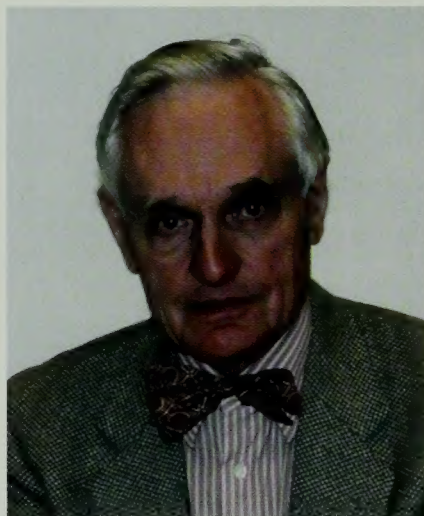


## THE FACULTY OF THE MCZ

The MCZ's original charter, signed in 1859, mandates that the Museum's activities be overseen by a governing board called the Faculty of the Museum of Comparative Zoology.

The MCZ is fortunate to have a governing board with a broad spectrum of professional experience and personal interests in the natural world. The Faculty is dedicated to sustaining the MCZ's reputation as a leader in zoological research, education and outreach, and ensuring its future standing, both academically and fiscally.

This past year brought many changes to the composition of the MCZ Faculty. The MCZ would like to take this opportunity to both acknowledge the services of our longstanding members and to welcome new Faculty members to the MCZ community. In addition to the listed members, the Faculty also includes Harvard University President Drew Gilpin Faust.



### **Dr. John D. Constable**

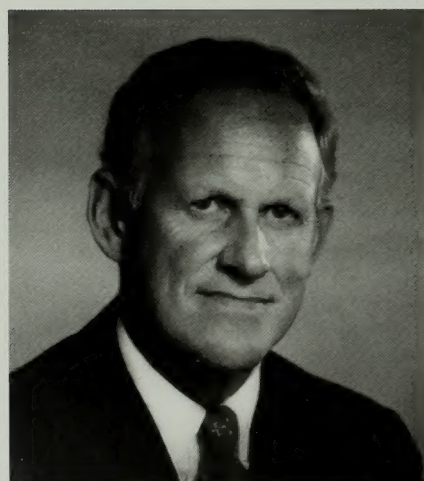
Dr. Constable, a member of the Faculty since 1985, is a graduate of Harvard Medical School and a pioneer in burn reconstructive surgery. He served as a board member of the World Wildlife Fund-US and chairman of the Conservation Committee of the New England Aquarium.

Dr. Constable is one of the founding members of the Indochina Surgical Educational Exchange (ISEE), giving Vietnamese doctors the opportunity to train in medical institutions in the United States.

### **Mr. Robert G. Goelet**

Mr. Goelet is a Harvard graduate and the chairman of GxG Management, LLC. He has a passion for natural history and has served on the Faculty since 1981.

He served as the eighth president of the American Museum of Natural History, president of the New York Historical Society and the New York Zoological Society, and director of the National Audubon Society.



### **Mr. George Putnam, Jr.**

Mr. Putnam joined the Faculty in 1985. He served as chairman of Putnam Investment Management Company in Boston for over thirty years.

He obtained his MBA from Harvard Business School and an honorary LL.D. from Harvard University. In addition to being a former Overseer and Treasurer for Harvard University, Mr. Putnam has served as a trustee of many medical, scientific, educational and cultural organizations.







**Mr. George Putnam, III**

Mr. Putnam has recently joined the Faculty. He is a graduate of Harvard College, Harvard Business School and Harvard Law School, and is currently president of New Generation Advisors, LLC, and chairman of New Generation Research, Inc.

He is a trustee of several educational organizations, the Putnam Group of Mutual Funds and the Marine Biological Laboratory in Woods Hole.



**Mr. David B. Stone**

The late Mr. Stone was considered the principal founder of the New England Aquarium in 1954, which set the standard for modern aquariums and helped to revitalize the Boston waterfront. He received his undergraduate degree and MBA from Harvard and was the president and chairman of North American Management Corporation.

He was on numerous boards of commercial, scientific, educational and charitable organizations. David served as a member of the Faculty for 32 years and will be greatly missed.



**Dr. Barbara Jil Wu**

Dr. Wu is a new member of the Faculty. She obtained her graduate degree from Harvard in evolutionary biology and molecular biology.

Since 1994 she has served in an advisory capacity for non-profit educational and research institutions, including the Woods Hole Oceanographic Institution, the Harvard School for Public Health and the Marine Biological Laboratory.

**Mr. Paul J. Zofnass**

Mr. Zofnass has recently joined the Faculty. An alumnus of Harvard Business School and Harvard Law School, he is president of The Environmental Financial Consulting Group, which provides advisory services to environmental, engineering and consulting firms.

A member of Harvard's Committee on University Resources for 30 years, he has also participated in various Harvard visiting and advisory committees.





# MCZ FACULTY-CURATORS



**Andrew A. Biewener**

*Charles P. Lyman Professor of Biology*

*Director, Concord Field Station*

*Chair, Department of Organismic and Evolutionary Biology*

Prof. Biewener's research focuses on the biomechanics, neuromuscular function and control of animal movement. His goal is to understand general principles that govern the biomechanical and physiological design of vertebrate neuromusculoskeletal systems.



**Scott V. Edwards**

*Professor of Biology*

*Alexander Agassiz Professor of Zoology*

*Curator of Ornithology*

Prof. Edwards' research focuses on the evolutionary biology of birds and relatives, using the guiding principles of population genetics, geographic variation, genome evolution, systematics and natural history.

Current projects include utilizing genomic technologies to examine sex-chromosome and genome evolution across the reptile-bird transition, speciation analysis and phylogeography in Australian and North American birds, as well as genomics of host-parasite co-evolution in house finches and their bacterial pathogens.

Tony Rinaldo



**Brian D. Farrell**

*Professor of Biology*

*Curator of Entomology*

Prof. Farrell's research is broadly concerned with whether the diversity of species on Earth is a cause or consequence of the diverse roles different species play in ecosystems, particularly between insects and plants.

The Farrell lab serves as a base for the Beetle Tree of Life project, a collaborative and comprehensive phylogenetic study of this most diverse group of animals.

Stu Rosner



**Gonzalo Giribet**

*Professor of Biology*

*Curator of Invertebrate Zoology*

Prof. Giribet's primary research focuses on the evolution, systematics and biogeography of invertebrate animals. Current projects in the Giribet lab include multidisciplinary studies for Assembling the Bivalve Tree of Life and for assessing deep molluscan phylogeny, as well as multiple projects involving research on arthropod

systematics and biogeography, sponges, sipunculans, platyhelminths and onychophorans. He is also interested in philosophical aspects of sequence data analysis, emphasizing homology-related issues.





**James Hanken**

*Professor of Biology  
Alexander Agassiz Professor of Zoology  
Curator of Herpetology  
MCZ Director*

Prof. Hanken utilizes laboratory-based analyses and field surveys to examine morphological evolution, developmental biology and systematics of

amphibians. Current areas of research include the evolution of craniofacial patterning; the developmental basis of life-history evolution; and systematics, taxonomy and evolution of neotropical and Asian salamanders.

Prof. Hanken also chairs the Steering Committee of the Encyclopedia of Life ([eol.org](http://eol.org)).

**Farish A. Jenkins, Jr.**

*Professor of Biology  
Alexander Agassiz Professor of Zoology  
Curator of Vertebrate Paleontology*

Prof. Jenkins' research interests are broadly in the area of vertebrate evolution, focusing on comparative anatomy of fossil and recent vertebrates and the evolutionary pathways of structural and functional development.

Prof. Jenkins maintains active field research in vertebrate paleontology and, in 2006, was part of an expedition that discovered *Tiktaalik roseae*, the missing link between fish and land animals, in the Canadian Arctic.

**Hopi E. Hoekstra**

*John L. Loeb Associate Professor of  
Natural Sciences  
Curator of Mammalogy*

Prof. Hoekstra combines field and laboratory work to understand the evolution of mammalian diversity from morphology to behavior. Her research focuses on the genetic basis of adaptive variation—identifying both the ultimate causes, such as the strength and agent of natural selection, and the proximate mechanisms, such as the underlying molecular and developmental changes, responsible for traits that help organisms survive and reproduce in the wild.

The Hoekstra lab contributes to a genomics revolution in natural history studies, tracking down genes that contribute to variation in wild populations. Members of the lab use an integrative approach that combines molecular genetic techniques, theoretical modeling, experimental tests, breeding studies and fieldwork.

Research in the Hoekstra lab focuses on understanding how biological variation is generated and maintained in natural populations. Of particular interest is the role natural selection plays in producing variation within a population (i.e., adaptation) as well as generating differences that lead to new species (i.e., speciation).

The lab is currently studying genetics, development and evolution of color and patterning; the molecular basis of reproductive traits associated with sexual selection; genetic architecture and evolution of behavior; and genetics of speciation. In addition to Prof. Hoekstra, the lab is comprised of seven postdoctoral associates, six graduate students, two visiting scientists, several undergraduates and a dog named Summit.



Bear Cieri Photography



Rose Lincoln/Harvard News Office

**Jonathan B. Losos**

*Monique and Philip Lehner Professor for  
the Study of Latin America  
Curator of Herpetology*

Prof. Losos' research focuses on the behavioral and evolutionary ecology of lizards, specifically how lizards interact with their environment and how lizard clades have diversified evolutionarily. His laboratory integrates approaches from systematics, ecology, behavior, genetics and functional morphology, taking both observational and experimental approaches in the field and in the laboratory.





## George V. Lauder

*Professor of Biology  
Henry Bryant Bigelow Professor of  
Ichthyology  
Curator of Ichthyology*

Prof. Lauder was recently appointed the Henry Bryant Bigelow Professor of Ichthyology. His research examines the structure, function and evolution of vertebrates, particularly fishes and amphibians. Additional interests include biological fluid mechanics, theoretical approaches to the analysis of form and function in organisms, and the history and philosophy of morphology and physiology.



Stephanie Mitchell

A major theme of research in the Lauder lab is fish robotics. Lab members and collaborators have developed a variety of robotic test platforms to examine fin and body kinematic and hydrodynamic function during locomotion. Robotic devices have the considerable advantage over studying live fish by allowing a variety of programmable motions that permit investigation of discrete components of naturally coupled movements.

Other research projects in the Lauder lab include hydrodynamics of locomotion in fishes, 3D kinematics of fish locomotion, maneuvering and stability in fish locomotion, evolution of functional design in fishes, and schooling behavior in fishes.

The Lauder lab has ten lab members, including two research assistants, a lab manager, three graduate students, two postdoctoral fellows and two undergraduate students who are conducting research on fish biomechanics. The lab contains two aquarium rooms with individual fish habitats, a 600-gallon aquarium, two 300-gallon aquaria and numerous 10- to 30-gallon aquaria.



## James J. McCarthy

*Professor of Biological Oceanography  
Alexander Agassiz Professor of Biological  
Oceanography  
Acting Curator of Malacology*

Prof. McCarthy's research focuses on factors that regulate the processes of primary production and nutrient supply in the ocean.

Through controlled laboratory studies and field investigations, Prof. McCarthy and his group examine the effects of strong seasonal or interannual climate change on marine life and biogeochemical systems.



## Naomi E. Pierce

*Sidney A. and John Hessel  
Professor of Biology  
Curator of Entomology*

Prof. Pierce's research uses molecular and morphological data to reconstruct the evolutionary history of Lepidoptera. The goal of this research is to clarify the systematics and classification of

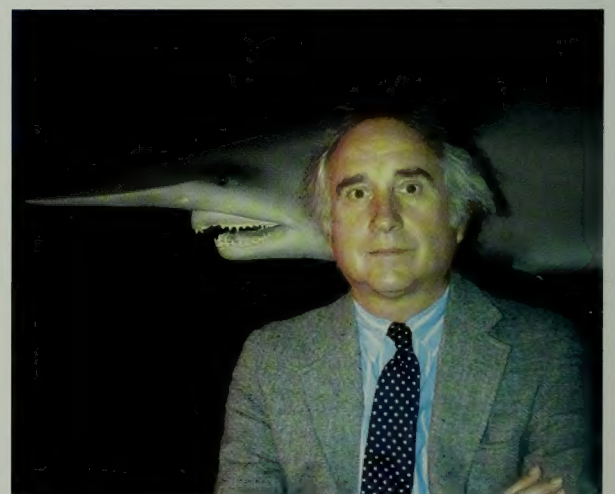
these insects, and to investigate how host plant and ant associations have shaped their patterns of diversification.

## Robert M. Woollacott

*Professor of Biology  
Curator of Marine  
Invertebrates*

Prof. Woollacott's research focuses on aspects of marine invertebrate life history such as

synchronization of reproductive events and ecology and physiology of larvae. Topics of particular interest include larval dispersal and population connectivity, as well as human impacts on the distribution of marine organisms.



Jean-Francois Bertrand





## MCZ EMERITI

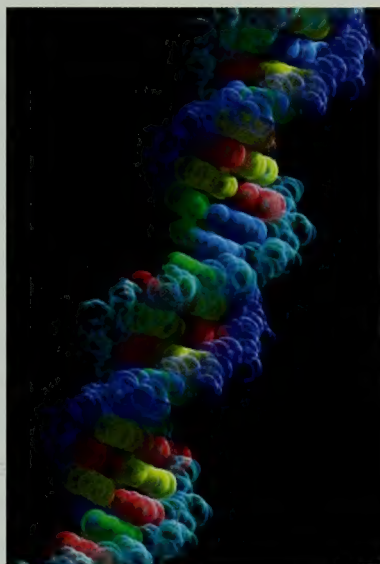


**Kenneth J. Boss**  
*Faculty-Curator Emeritus*  
*Professor of Biology, Emeritus*

Prof. Boss, former Curator of Malacology, has been with Harvard for 40 years. His research focus is the classification, systematics and evolution of molluscs, using data from shell morphology, anatomy and zoogeography to analyze the phylogenetic relationships within various groups of gastropods and bivalves. He has also published on the history of malacology. Prof. Boss has contributed extensively to the *Occasional Papers on Mollusks* and formerly served as editor for *Breviora* and the *Bulletin of the Museum of Comparative Zoology*.

**Richard C. Lewontin**  
*Professor of Biology, Emeritus*  
*Alexander Agassiz Professor of Zoology, Emeritus*

An evolutionary geneticist, Prof. Lewontin pioneered the field of molecular population genetics by merging molecular biology and evolutionary theory, as well as the philosophical and social implications of genetics and evolutionary theory. Prof. Lewontin's current research involves computer simulation and evaluation of statistical tests for selection. Among his many books are *The Genetic Basis of Evolutionary Change*, *Biology as Ideology: the Doctrine of DNA*, *Human Diversity*, and *The Triple Helix: Gene Organism and Environment*. He served as President of the Society for the Study of Evolution, the American Society of Naturalists and the Society for Molecular Biology and Evolution.



**Edward O. Wilson**  
*Honorary Curator in Entomology*  
*Pellegrino University Professor, Emeritus*

Prof. Wilson is considered the founder of sociobiology and evolutionary psychology and has developed the basis of modern biodiversity conservation. He has received many of the world's leading prizes in recognition of his research and environmental activism. He was awarded two Pulitzer Prizes for his books *The Ants* (1990, with Bert Hölldobler) and *On Human Nature* (1978). In 2007, Prof. Wilson received the Technology, Entertainment, Design (TED) Prize, where he articulated the concept of the Encyclopedia of Life—a contemporary, dynamic web page for every named species.



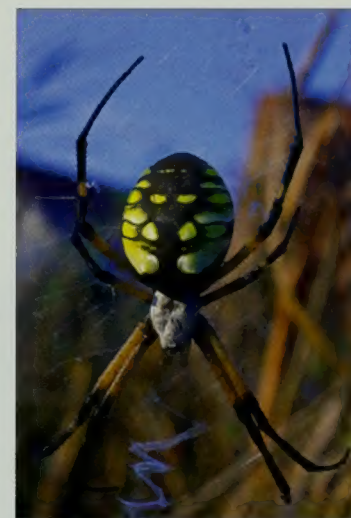
**A. W. "Fuzz" Crompton**  
*Faculty-Curator Emeritus*  
*Fisher Professor of Natural History, Emeritus*

Prof. Crompton, former Curator of Mammalogy, was the Director of the MCZ from 1970 to 1982 and the former Director of the Peabody Museum of Natural History, Yale University and the South African Museum, Capetown. His primary research interests are the origin and evolution of mammals, functional anatomy, neural control and evolution of feeding in recent and fossil vertebrates. Prof. Crompton is a fellow of the American Academy for Arts and Sciences and the American Association for the Advancement of Science. He received two Guggenheim fellowships for his research on vertebrate paleontology and functional morphology.



**Herbert W. Levi**  
*Faculty-Curator Emeritus*  
*Professor of Biology, Emeritus*

A former Curator of Arachnology, Prof. Levi's research focuses on the taxonomy of new world orb weaving araneid spider genera. The author of *Spiders and Their Kin*, as well as numerous articles on various spider genera, his research has made possible identification of 1,500 species in 66 genera in the Americas. Prof. Levi served as president of the International Society of Arachnology and, in 2007, won the ISA's Eugene Simon Award for lifetime achievement for his immense influence on spider research. He has made his extensive collection of drawings of orb weavers' genitalia available online.







OEB 167: Herpetology

## COURSES IN 2009–2010 LED BY MCZ FACULTY-CURATORS

### Organismic and Evolutionary Biology

#### OEB 10: Foundations of Biological Diversity (undergraduate)

*Brian D. Farrell (and N. Michele Holbrook)*

An integrated approach to the diversity of life, emphasizing how chemical, physical, genetic, ecological and geologic processes contribute to the origin and maintenance of biological diversity.

#### OEB 51: Biology and Evolution of Invertebrate Animals (undergraduate)

*Gonzalo Giribet (and Cassandra G. Extavour)*

Introduction to invertebrate diversity with special emphasis on the broad diversity of animal forms, their adaptations to different ecosystems, and how these phenomena shape animal evolution.

#### OEB 53: Evolutionary Biology (undergraduate)

*Hopi E. Hoekstra (and Andrew J. Berry)*

Micro- and macro-evolution, ranging from population genetics through molecular evolution to the grand patterns of the fossil record.

#### OEB 57: Animal Behavior (undergraduate)

*Naomi E. Pierce (and Bence P. Olveczky)*

A review of the behavior of animals under natural conditions, with emphasis on both mechanistic and evolutionary approaches.

#### OEB 121a: Research in Comparative Biomechanics (undergraduate and graduate)

*Andrew A. Biewener, George V. Lauder  
(and Daniel E. Lieberman, Stacey A. Combes)*

Introduction to experimental techniques used to investigate the structure and physiology of vertebrates, where each instructor offers research projects that are undertaken in their laboratory.

#### OEB 121b: Research in Comparative Biomechanics (undergraduate and graduate)

*Andrew A. Biewener, George V. Lauder  
(and Daniel E. Lieberman, Stacey A. Combes)*

Optional extension of initial project undertaken in OEB 121a into a thesis research project.

#### OEB 130: Patterns and Processes in Fish Diversity (undergraduate and graduate)

*George V. Lauder*

Fishes inhabit diverse aquatic environments including deep seas, intertidal zones, coral reefs, polar waters, the vast Amazonian basin and great East African lakes. To explore this unparalleled diversity, the course emphasizes bridging traditional academic boundaries with integrative analyses of the biology underlying rapid evolutionary radiations and stasis.

#### OEB 139: Evolution of the Vertebrates (undergraduate and graduate)

*Farish A. Jenkins, Jr.*

Origination and evolution of the major groups of vertebrates, with emphasis on the anatomical and physiological transformations that occurred during the transitions to diverse lineages of fish, amphibians, reptiles, birds and mammals.

#### OEB 141: Biogeography (undergraduate and graduate)

*Gonzalo Giribet*

Biogeography aims to explain distributions of organisms through historical and ecological factors. This course focuses on the history of biogeographic research, developments in the area of historical biogeography and on ecological processes that affect distributions of whole clades.

OEB 139: Evolution of the Vertebrates

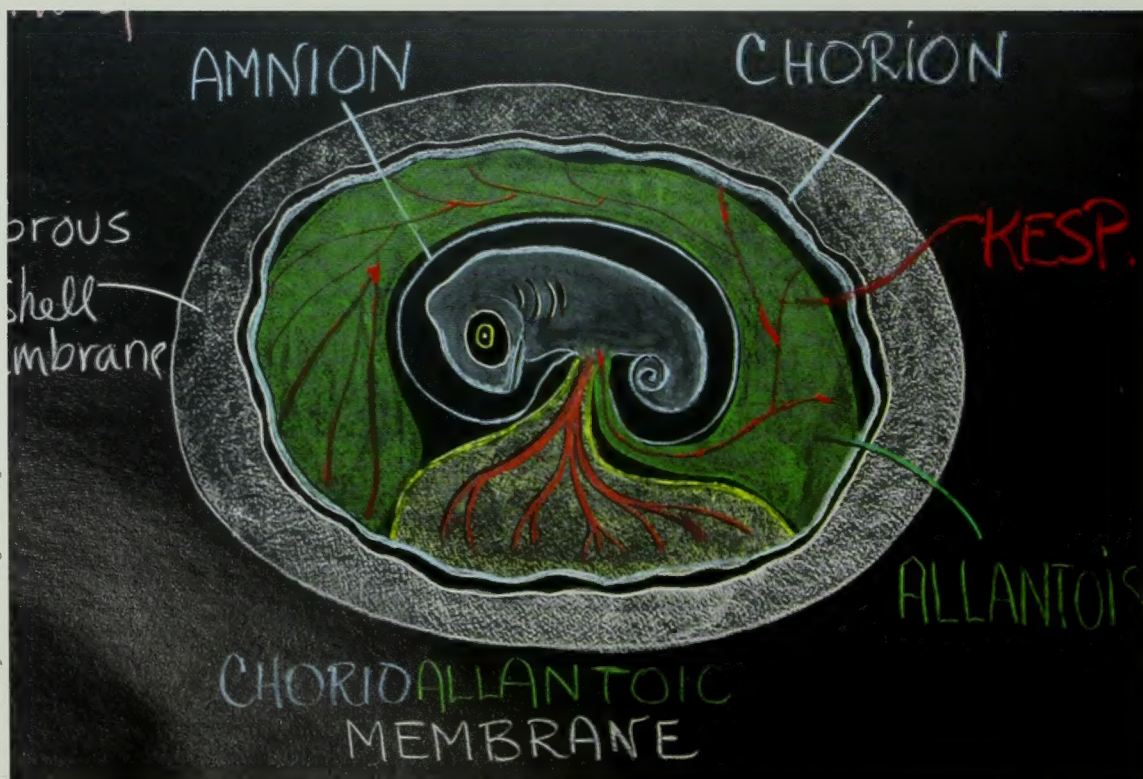


Illustration by Farish A. Jenkins, Jr.







Gonzalo Giribet

**OEB 155r: Biology of Insects  
(undergraduate and graduate)**

*Naomi E. Pierce (and Michael R. Canfield)*

Introduction to the major groups of insects—life history, morphology, physiology and ecology—through a combination of lecture, lab and field exercises.

**OEB 167: Herpetology (undergraduate and graduate)**

*James Hanken and Jonathan Losos*

An introduction to the biology of amphibians and reptiles. Lectures and laboratories examine the morphology, systematics, natural history, behavior, ecology, evolutionary relationships and biogeography of all major taxa.

**OEB 173: Comparative Biomechanics  
(undergraduate and graduate)**

*Andrew A. Biewener (and Jacques Dumais)*

An exploration of how animals and plants contend with their physical environment, considering their biomaterial properties, structural form and mechanical interaction with the environment.

**OEB 231: Adaptation (graduate)**

*Hopi E. Hoekstra*

This discussion-based course covers the latest advances in the study of adaptation with a focus on controversial issues and integrative approaches.

**OEB 234: Topics in Marine Biology  
(graduate)**

*Robert M. Woollacott*

Human impacts on marine life and ecosystems of the sea.

**OEB 261r: Developmental Mechanisms of  
Evolutionary Change (graduate)**

*James Hanken (and Arkhat Abzhanov)*

Graduate seminar course in evolutionary developmental biology discussing the latest advances in understanding the cellular and molecular developmental mechanisms that underlie important evolutionary phenomena.

**OEB 275r: Phylogenetics in the Era of  
Genomics (graduate)**

*Scott V. Edwards*

A survey of the changing landscape of molecular systematics brought on by the power of modern genomics. Emphasis will be on the challenges of combining DNA sequence data from many genes and the rise of species trees as a paradigm in systematics.

**OEB 282: Genomics and Evolution of  
Infectious Disease (graduate)**

*Scott V. Edwards (and Pardis Sabeti)*

Infectious diseases rapidly evolve to evade our immune systems, drugs and vaccines to remain agents of great morbidity and mortality. We will investigate the genome evolution of these pathogens and our intervention strategies for them past and present.

**Graduate Courses of  
Reading and Research**

**OEB 307: Biomechanics, Physiology and  
Musculoskeletal Biology**

*Andrew A. Biewener*

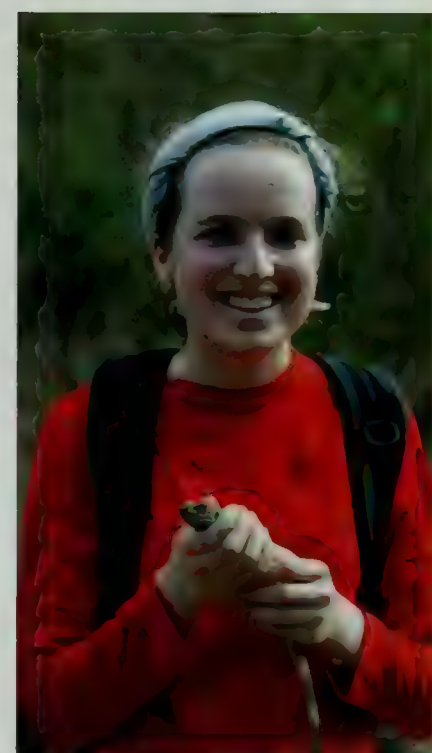
**OEB 310: Metazoan Systematics**

*Gonzalo Giribet*



Gonzalo Giribet

*OEB 51: Biology and Evolution of  
Invertebrate Animals*



Luke Mahler

*OEB 167: Herpetology*







OEB 234: Topics in Marine Biology

**OEB 320: Biomechanics and Evolution of Vertebrates**

*George V. Lauder*

**OEB 323: Advanced Vertebrate Anatomy**

*Farish A. Jenkins, Jr.*

**OEB 325: Marine Biology**

*Robert M. Woollacott*

**OEB 334: Behavioral Ecology**

*Naomi E. Pierce*

**OEB 341: Coevolution**

*Brian D. Farrell*

**OEB 345: Biological Oceanography**

*James J. McCarthy*

**OEB 355: Evolutionary Developmental Biology**

*James Hanken*

**OEB 362: Research in Molecular Evolution**

*Scott V. Edwards*

**OEB 367: Evolutionary and Ecological Diversity**

*Jonathan Losos*

**OEB 370: Mammalian Evolutionary Genetics**

*Hopi E. Hoekstra*

**Freshman Seminar**

**Freshman Seminar 22t: Why We Animals Sing (the Way We Do) (freshman only)**

*Brian D. Farrell*

Explores the sounds and structures of the different kinds of acoustic animals—including birds, mammals, frogs and insects—and the different kinds of habitats in which they produce their songs and calls. Students learn to imitate other species by slowing down their calls and will explore the evolution and biology of music in humans.

**Life Sciences**

**LIFESCI 2: Evolutionary Human Physiology and Anatomy (undergraduate)**

*George V. Lauder, Andrew A. Biewener (and Peter T. Ellison, Daniel E. Lieberman)*

Explores human anatomy and physiology from an integrated framework, combining functional, comparative and evolutionary perspectives on how organisms work.



OEB 130: Patterns and Processes in Fish Diversity



Stephanie Hillsgrrove





## Core Curriculum

### SCIENCE B-53: Marine Biology (undergraduate)

*Robert M. Woollacott*

Explores the life histories and adaptations of marine life and the ecosystems of the sea. Emphasis is placed on human impacts on marine organisms and ecosystems.

### SCIENCE B-65: Evolutionary Biology (undergraduate)

*Jonathan Losos*

The process of biological evolution, the way the biosphere and its inhabitants have changed through time, and how human actions affect the evolutionary process.

## Environmental Science and Public Policy

### ESPP 90e: Conservation Genetics (undergraduate)

*H. Bradley Shaffer, Hrdy Visiting Fellow*

Genetics, genomics and conservation biology have a long and complex history of interaction. This course examines the ways genome-enabled science can be used to guide effective conservation and management of endangered taxa.

## Harvard Extension School and Harvard Summer School

### BIOS E-225: Human Impacts on Marine Communities

*Robert M. Woollacott*

How anthropogenic-driven events are impacting the structure and function of marine communities.

### BIOS S-74: Marine Life and Ecosystems of the Sea

*Robert M. Woollacott*

The life history and adaptations of marine life and the ecosystems of the sea, with emphasis on understanding the fragility and resilience of marine systems in the face of anthropogenically driven perturbations.

### BIOL S-112: Study Abroad at Oxford: Darwin and the Origins of Evolutionary Biology

*Naomi E. Pierce (and Andrew Berry)*

The history of thought on evolution from its mythic beginnings in creation stories through the theories of Charles Darwin.



Luke Mahler

*OEB 167: Herpetology*

### BIOL S-113: Study Abroad at Oxford: Darwin and Contemporary Evolutionary Biology

*Naomi E. Pierce (and Andrew Berry)*

The history of evolutionary biology in the post-Darwinian world, following strands of thought either introduced or ignored by Darwin in *On the Origin of Species* through to the present.



Jonathan Ruel

*Graduate students tour the MCZ collections during the OEB Open House for the Harvard Integrated Life Sciences (HILS) graduate program.*







## COLLECTIONS ON THE MOVE

In 2008, the MCZ welcomed the Northwest Building as a new neighbor to Harvard's north campus. Soon, specimens from tiny shells to preserved crane and mountain lion study skins will call the building home.

For 150 years the MCZ has been amassing a historic and scientifically priceless collection, which is currently estimated at more than 21 million specimens. This collection continues to grow, challenging existing storage spaces and making the completion of the Northwest Building eagerly anticipated. Construction has begun on two of the building's four below-ground floors to outfit almost 48,000 gross square feet for state-of-the-art laboratories, special preparations areas, a classroom and climate-controlled collections storage rooms for the MCZ.

"Once the space was secured, the question became which collections to move," said **Linda Ford**, Director of Collections Operations. "It's been a long process of defining what we have, seeing what fits and how much space it will need."

There were numerous factors in the complex selection process, conducted with the assistance of Toronto-based consulting firm WeatherstonBruer Associates, which

generated multiple scenarios for evaluation. On a macro level, the process considered the space available, the size of the collections, the space they would need when uncrowded, the number of people who work with them, special labs and preparation areas, and the growth of the collections and their associated staff over the next twenty years.

On a more discrete level, the size of the specimens and their storage medium became important. "Dry" collections were welcome, but alcohol-based or "wet" collections were excluded due to building codes. Oversized specimens, such as large fossils and mounted animals, were also not included because of space limitations.

As a result of this long and detailed assessment, it was decided to relocate all or part of eight collections to floors B2 and B3. These include the whole of Vertebrate Paleontology and Invertebrate Paleontology, and the dry collections of Mammalogy, Ornithology, Malacology and Marine Invertebrates. Collections moving in part are Entomology fossils and dry collections of Invertebrate Zoology.

The installation will occur in three phases over the next three academic years. The B2 level, consisting of preparation labs, receiving space and the Mammalogy management and collections space, will be completed during AY 2010–11.

Next will be the installation of B3 South, planned for AY 2011–12. This space will house the management and collections areas for Ornithology and possibly management areas for Invertebrate Paleontology and Malacology. Upon completion of the second phase, the 420 Blaschka "glass animals"—



*The Northwest Building*

Cyndi A. Wood





which require similar temperature and humidity control for preservation as other specimens—will also move to specialized cabinets.

B3 North, housing the management area for Vertebrate Paleontology and collections space for Invertebrate Paleontology, Vertebrate Paleontology, Malacology, Marine Invertebrates, Invertebrate Zoology and Entomology fossils, is scheduled for completion in AY 2012–13.

One attractive aspect of the move is the installation of new compacting cabinets, which hold more specimens than older-style fixed cabinets and provide improved access to specimens. To visualize the volume of space required to properly house these massive collections in the Northwest Building, just imagine 3,386 standard household refrigerators.

The Mammalogy collection will be the first to move in AY 2010–11, and the department has been readying its specimens since March 2010. “Over several months, Mammalogy staff and casual help have been hard at work. The collection is being inventoried and reorganized to streamline the move, and cleaned when necessary,” said **Judy Chupasko**, Curatorial Associate in Mammalogy. Immediately prior to the move, specimens will be secured, packed and labeled for transport. Similar preparations are ongoing in the other departments.

In time, bright and spacious work areas will greet researchers—including MCZ faculty-curators, students and visiting researchers from around the world—as they use the MCZ’s ever-expanding collections to unlock life’s mysteries.

## Releasing the Whales

And what better way to welcome visitors than with two spectacular whale skeletons in the lobby of the Northwest Building? Dramatically displayed in natural postures, the bottlenose whale is arranged in a twisting dive down to the lower level, while the

killer whale is poised in a jumping breach position.

The 21-foot killer whale and the 24-foot bottlenose were collected near the Faroe Islands in the 1880s. Both specimens were displayed in the MCZ Sea Mammal Room before being removed for space reasons in the 1930s. The skeletons were stored in the MCZ attic, a common practice by museums at the time because skeletons were thought to be hardy. However, we now know that skeletons are among the most fragile museum specimens, and variable temperature and humidity are exactly the types of conditions that are harmful.

According to MCZ Director **James Hanken**, the installation has multiple benefits: restoring and displaying the two specimens, enhancing the building’s lobby and making room in the MCZ attic. “We’ve wanted to move the whales out of the attic for several years,” Hanken said, “and the Northwest Building provided the perfect opportunity. It’s not too often that we find space to display one whale, much less two.”

To ready the specimens for their new installation, they were removed from the attic and sent to the specialty preparation firm Whales and Nails in Seal Cove, Maine. The firm cleaned and degreased the skeletons, then performed repairs and created models of missing bones. During the day-and-a-half installation in January 2010, the firm hung the whales from specially reinforced steel frames in the lobby.



Catherine Weisel



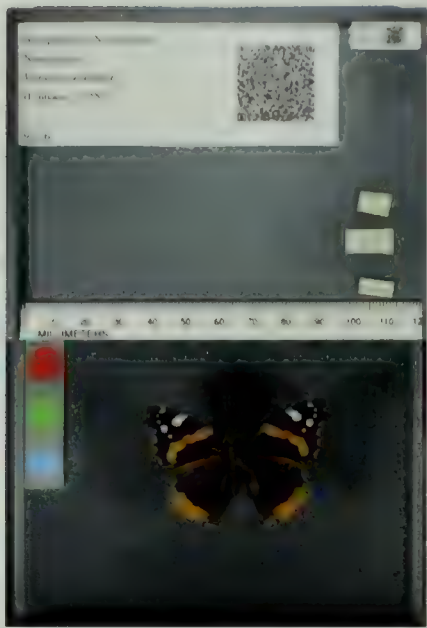
Linda Ford and Judy Chupasko

Stephanie Mitchell





Paul Morris



"There is no better way to be reminded of the majesty and the sheer mass of these whales than to watch their skeletons being hoisted up some 50 feet into the air," said **Hopi E. Hoekstra**, John L. Loeb Associate Professor of Natural Sciences and Curator of Mammals.

Using the main floor railing as the waterline, the bottlenose is shown heading for a deep dive, while the surface-dwelling killer whale is emerging from the "ocean" in a typical spy-hop breach maneuver.

### Digital Data: More than a Photo

Natural history collections are of vital importance in understanding the critical issues of our time: climate change, biodiversity loss, emerging diseases, invasive species and other environmental challenges.

But in order for collections to be of use, they must be accessible to researchers. Much of the data in natural science collections is "dark," meaning it is not available digitally.

Traditionally, researchers have had to travel to examine the specimens in person, an expensive and time-consuming effort.

Online availability of the collections is a high-priority directive for the MCZ, and multiple Museum-wide, cross-disciplinary initiatives are underway to promote digitization of



Paul Morris

the collections, enhance data quality and mobilize this data so it can be used.

One of the challenges in digitization is to effectively capture data from individual, often fragile, and historically important specimens. "The MCZ Lepidoptera Rapid Data Capture Project demonstrates our successful method of obtaining robust data associated with the approximately 200,000 butterfly specimens," says **Rod Eastwood**, MCZ postdoctoral fellow. "The project does this by separating specimen handling from data capture, imaging both labels and specimens, then capturing label data from the images."

The workflow of this project occurs in three steps. First, an entomologist creates taxonomic labels with machine-readable barcodes for each species or subspecies. Next, staff remove each specimen from its tray, placing it on a carrier with the taxonomic label and pin labels, and then making a digital image. Lastly, a database record is created automatically and augmented with a transcription of the pin label data, then finalized when an entomologist performs a quality check. Data are then made available for mobilization and global analysis.

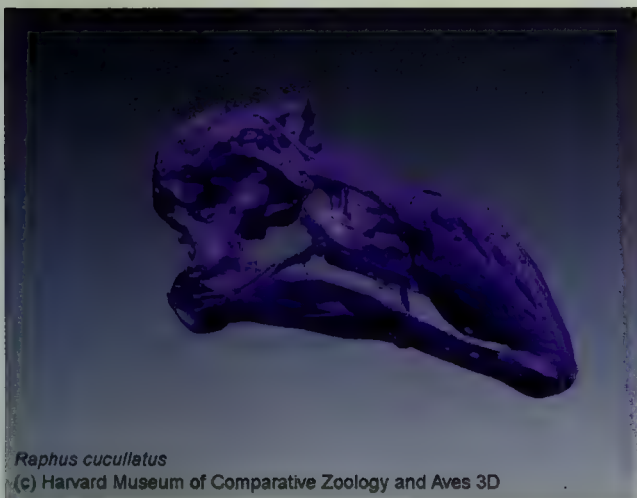
Paul Morris





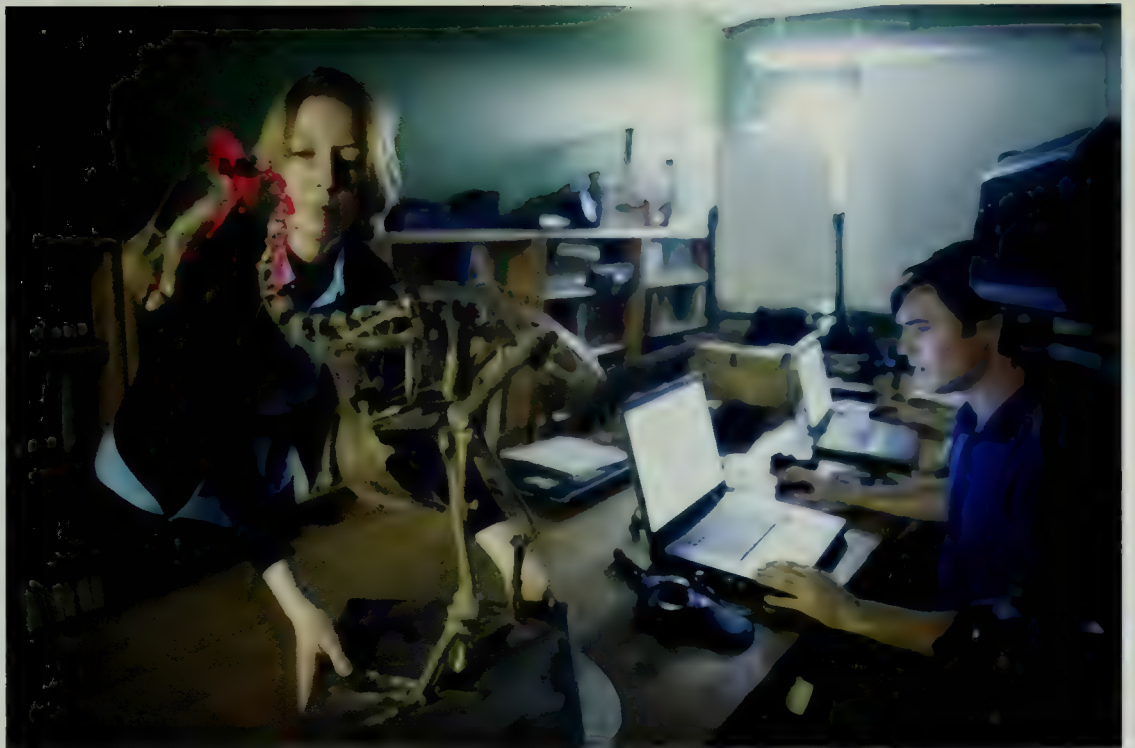
Another innovative digitization effort is **Aves 3D**, funded by the National Science Foundation and headed by **Scott Edwards**, Alexander Agassiz Professor of Zoology and Curator of Ornithology at the MCZ, and Leon Claessens, Assistant Professor of Biology at the College of the Holy Cross. Aves 3D uses advanced laser scanners to create three-dimensional digital models of the 12,000 bird skeletons in the MCZ collection.

“The Aves 3D database is making a wide representation of both living and extinct bird species accessible to scientists, educators, and the public,” explains Professor Edwards. “Users can rotate and zoom in on the breastbone of an American flamingo, the wishbone of a king penguin or the skull of an extinct dodo.”



The effort, produced largely through undergraduate student research, allows for the rapid global dissemination of three-dimensional digital data in a format ready for quantitative and qualitative analysis. It also serves as an online digital archive of museum collections, helping to increase use of these resources while reducing handling of the actual specimens. Explore it at [aves3d.org](http://aves3d.org).

Data from both projects will eventually migrate to the master Museum-wide database, MCZbase. This migration effort began more than a year ago and MCZbase now contains almost 900,000 records representing approximately seven million specimens. Specimen records from the entirety of the



Justine Ide

Herpetology, Mammalogy, Malacology and Ichthyology collections have been migrated to the database. Migration of newly captured data from these collections is ongoing, and migration of the Invertebrate and Vertebrate Paleontology collections has begun.

Searching capability includes current MCZ data, and in some cases specimen images, for the migrated collections. MCZbase shares data with discipline-specific and global initiatives, such as the Global Biodiversity Information Facility (GBIF), Encyclopedia of Life (EOL), MaNIS, HerpNET, ORNIS, FishNet 2 and VertNet.

In this way “dark” data comes into the light, facilitating diverse research and educational projects and leading to a better understanding of species diversity, distribution, anatomy, function and evolution.



Luke Mahler

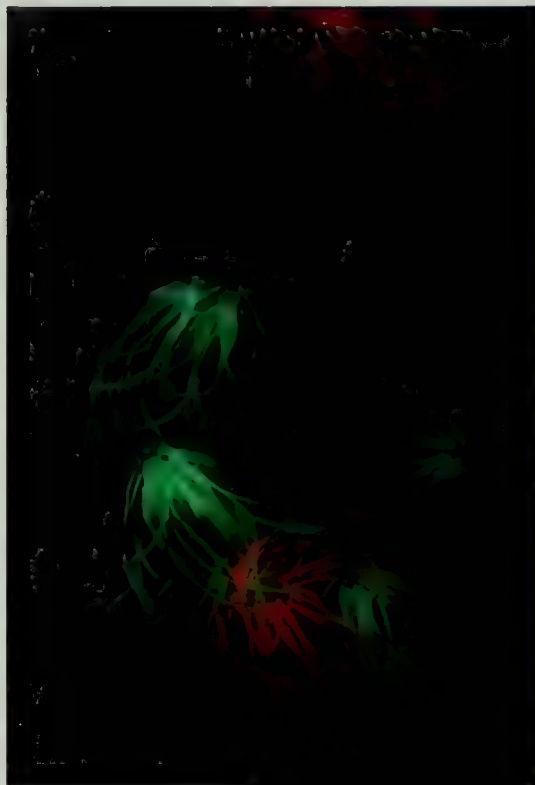




# MCZ RESEARCH MAKING HEADLINES

## Sperm Team Up for Speed, Preferring Brothers

Heidi Fisher



It's a fact: males compete for females. It's also known that faster swimming sperm have a competitive advantage in their race to fertilize the egg. But sperm recognizing and teaming up with their brethren to increase their speed? This is news.

In research published in *Nature*, **Heidi S. Fisher** and **Hopi E. Hoekstra** demonstrate that sperm from two species of closely related mice, *Peromyscus polionotus* and *Peromyscus maniculatus*, behave very differently.

In the promiscuous deer mouse, *P. maniculatus*, females mate with multiple males, while the oldfield mouse, *P. polionotus*, is monogamous. Postdoctoral fellow Fisher extracted sperm from several individuals of each species and fluorescently dyed each sample red or green. Creating various combinations of sperm from each species, the team observed the sperm's behavior under a microscope.

The sperm of both species clustered together for increased speed, linking up through hooked structures and either clustering together at their heads or forming "trains," linking head to body.

However, sperm from the promiscuous deer mice strongly preferred to group with sperm from the same species and even from the same individual. Sperm of the monogamous oldfield mice, on the other hand, grouped indiscriminately with sperm from other individuals and species, a condition that is unlikely to occur in nature.

These findings suggest that sperm in promiscuous species have evolved mechanisms to identify their kindred sperm, whereas sperm in monogamous species have not found these mechanisms necessary.

The work of Fisher and Prof. Hoekstra, funded by the National Institutes of Health and the Arnold and Mabel Beckman Foundation, received extensive media attention.

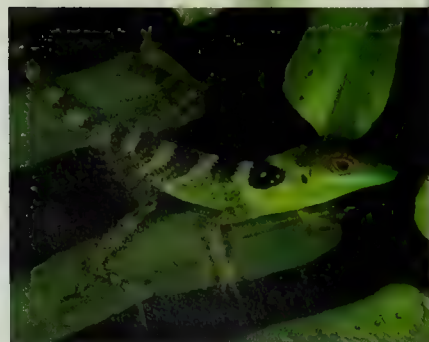
Fisher HS, Hoekstra HE (2010) Competition drives cooperation among closely-related sperm of deer mice. *Nature* 463:801-803.



LIZARDS  
IN AN EVOLUTIONARY TREE

JONATHAN B. LOSOS

ECOLOGY AND ADAPTIVE RADIATION OF  
ANOLES



## Lizards in an Evolutionary Tree

Evolutionary biologist **Jonathan B. Losos** has authored *Lizards in an Evolutionary Tree: Ecology and Adaptive Radiation of Anoles*, a work that reviews and synthesizes decades of study and an enormous volume of literature on the Caribbean lizards of the genus *Anolis*.

Adaptive radiation—possibly the single most important source of biological diversity in the living world—results when a single ancestral species gives rise to many descendants, each adapted to a different part of the environment. One of the best-studied examples involves Caribbean *Anolis* lizards.

With about 400 species, *Anolis* has played a critical role in the development of ecological theory. It has become a model system exemplifying the integration of ecological, evolutionary and behavioral studies to understand evolutionary diversification.

In his book, Professor Losos illustrates how different scientific approaches to the questions of adaptation and diversification can be integrated and examines evolutionary and ecological questions of interest to a broad range of biologists.

In October 2009, the MCZ hosted 125 anole biologists from eight countries for the 6<sup>th</sup> *Anolis* Symposium. On this occasion, the newly renovated herpetology library was dedicated in honor of Ernest E. Williams, the MCZ's late curator of herpetology and a pioneer in researching *Anolis*. Prof. Williams inspired Prof. Losos and many other Harvard-trained biologists to research the genus, making it an important group to study ecological and evolutionary principles.

Losos JB (2009) *Ecology and Adaptive Radiation of Anoles*. Berkeley: University of California Press.





## Robotic Fins Provide Insight into Fish Propulsion

Investigating the way a fish moves through water involves detailed study of biology, hydrodynamics and the mechanics of motion. But studying live fish, and coaxing them into performing all the necessary movements, can be a challenging and time-consuming way to capture data.

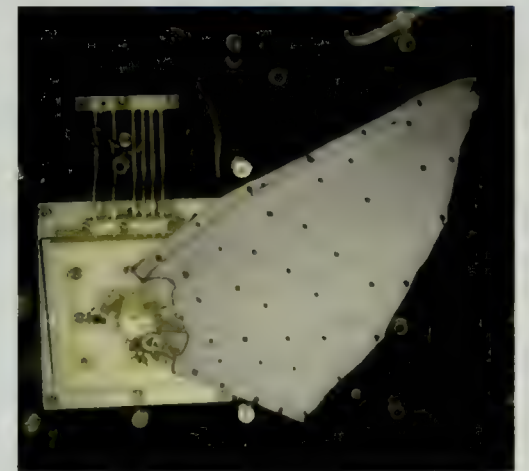
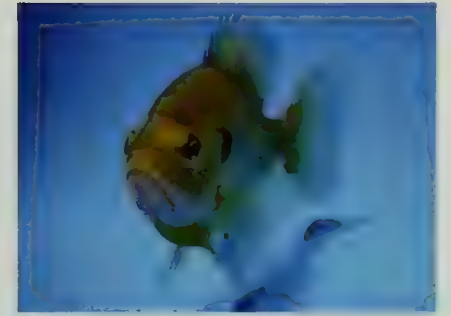
In a series of articles published by **George V. Lauder** and the Lauder lab in collaboration with colleagues, they discuss the advantages of and findings from their use of biorobotic fins. The researchers developed the artificial fins through detailed analysis of the anatomy, movement and behavior of bluegill sunfish (*Lepomis macrochirus*).

In the lab, robotic models of the pectoral fins (those close to the head) and the caudal (tail) fins were created by modeling the mechanical properties of the biological fins, captured by filming fish in a flow tank with multiple, synchronized high-speed cameras.

Unlike earlier models with stiff fins, these biorobotic fins bend. This enables understanding of how fin shape creates different forces and movements. Using robotic fins also permits analysis of quick, systematic changes to the fin and the manner in which the fin is used.

Professor Lauder and colleagues discovered that relatively subtle changes in a fin's shape and movement can significantly alter the magnitude and direction of the force it produces. When executing a maneuver, a fish contracts muscles that control its fins in order to modulate the stiffness and curvature of the fin rays. To further investigate this fin-fluid interaction, the team's future work will include biorobotic modeling of the sensory perceptions and motor control of the fins.

Lauder GV, Anderson EJ, Tangorra J, Madden PG (2007) Fish biorobotics: kinematics and hydrodynamics of self-propulsion. *Journal of Experimental Biology* 210:2767-80.



## Our Planet and Its Life, Origins and Futures

**James J. McCarthy**, in his presidential address to the American Association for the Advancement of Science, reflected on "Our Planet and Its Life, Origins, and Futures." This address, delivered in the year marking the 150<sup>th</sup> anniversary of Darwin's *On the Origin of Species*, began by looking back to that time. Inventions and discoveries in 1859 made possible the combustion of coal, oil and natural gas that fueled the industrial era.

Since then the human population has increased from 1 billion to 6.8 billion and consumption of the Earth's resources has grown even more. Global use of fossil fuels provides about 80% of the energy we use, but the physical and biological systems that remove the resulting carbon dioxide waste from the atmosphere are unable to keep up. More than half of the CO<sub>2</sub> released by human activities today will remain in the atmosphere for up to a century.

In his talk and the subsequent paper published in *Science*, Professor McCarthy offers a survey of the development of climate

research, technology, thinking and issues. He stresses that in order to diminish the profoundly negative and costly impacts of climate change and sea level rise decades from now, action must be taken today to reduce CO<sub>2</sub> emissions.

Prof. McCarthy ends on an optimistic note, recognizing the increasing role scientists are playing in the U.S. administration's pursuit and application of science in this country. He also is hopeful that cooperative efforts among the Earth and life sciences, and enhanced partnerships with the engineering and social science communities, will provide new understanding as society steers to a future that diminishes risk to the well being of human and other life on the planet.

McCarthy JJ (2009) Reflections on: Our planet and its life, origins, and futures. *Science* 326:1646-1655.



James J. McCarthy

Jon Chase





## Another Evolutionary Mystery Solved

A clear picture of evolutionary relationships among species is needed to reconstruct how they diversified physically and ecologically over time.

In the animal tree of life, placement of the flatworm group Acoelomorpha has great importance for understanding critical events in animal evolution, in particular the origin and evolution of numerous organ systems. Yet, positioning this group has been problematic for taxonomists due to their rapid evolution and a lack of genomic data for certain acoelomorph groups.

In a study published in *Proceedings of the Royal Society of London*, **Gonzalo Giribet** and an international team of scientists place Acoelomorpha at the first evolutionary branching for bilateral animals. The researchers determined that this group of simple worms is a product of the deepest evolutionary split within bilateral creatures—multicellular organisms that, like humans, have bilaterally symmetrical body forms.

The team employed a genetic sequencing technique called expressed sequence tags, which utilized many genes from a large number of species. To obtain and analyze this massive amount of data, the team designed new automated methods for identifying and selecting common genes across different species and developed highly effective supercomputing tools to reconstruct relationships from DNA sequences.

The study, funded by the National Science Foundation's Protosome Assembling the Tree of Life Project, represents the most computationally intensive genetic sequencing analysis to date: 2.25 million supercomputer processor hours were required to obtain the results.

Hejnol A, Obst M, Stamatakis A, Ott M, Rouse GW, Edgecombe GD, Martinez P, Baguña J, Bailly X, Jondelius U, Wiens M, Müller WEG, Seaver E, Wheeler WC, Martindale MQ, Giribet G, Dunn, CW (2009) Assessing the root of bilaterian animals with scalable phylogenomic methods. *Proceedings of the Royal Society B* 276:4261-4270.

## Genetic Sex Determination Populates Prehistoric Seas

New analysis of extinct sea creatures suggests that the transition from egg-laying to delivering live-born young opened up evolutionary pathways that allowed these ancient species to adapt to life in open oceans and thrive.

to give birth in the water to live young, as opposed to laying eggs on a nesting beach, and may have played a surprisingly strong role in adaptive radiations and in colonization of the world's oceans by a diverse array of species.

Postdoctoral fellows **Chris L. Organ** and **Daniel E. Janes** report in *Nature* that the evolution of live-born young in extinct marine reptiles—mosasaurs, sauropterygians and ichthyosaurs—hinged on the evolution of sex-determining genes. Freed from the need to move and nest on land, extreme physical

adaptations for life in the open ocean evolved in each group, such as the fluked tails, dorsal fins and wing-shaped limbs of ichthyosaurs.

In many egg-laying species, incubation temperature is the primary determinant of the sex of offspring. Determining sex by genetic means allowed marine reptiles

Mosasaurs, sauropterygians and ichthyosaurs spread throughout the Mesozoic seas between 251 million and 100 million years ago. All three groups of extinct marine reptiles breathed air, but they evolved other adaptations to life in the open ocean, such as fin-shaped limbs, streamlined bodies and changes in bone structure. Some evolved into enormous predators, such as porpoise-like ichthyosaurs that grew to more than 20 meters long. Ichthyosaurs, and possibly mosasaurs, even evolved tail-first birth, an adaptation that helps the air-breathing young of modern whales and porpoises avoid drowning during birth.

Organ CL, Janes DE, Meade A, Pagel M (2009) Genotypic sex determination enabled adaptive radiations of extinct marine reptiles. *Nature* 461:389-392.

Eric Rottinger/Kahikoi Images

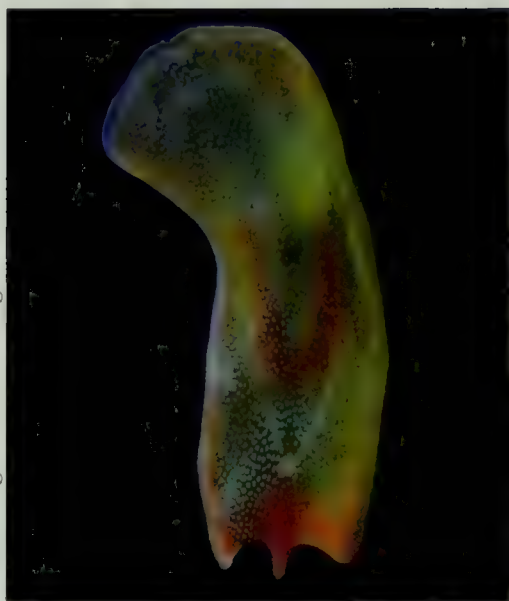
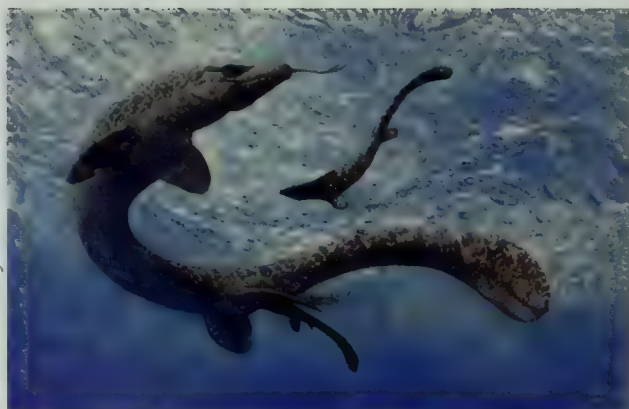


Illustration by Dan Varner





## Altruistic Army Ants

Colonies of army ants are usually antagonistic to one another, attacking soldiers from rival colonies in border disputes that keep the colonies separate. But research by postdoctoral fellow **Daniel Kronauer** demonstrates that colonies can sometimes be cooperative instead of combative. In cases when an army ant colony loses its queen, its workers are absorbed, not killed, by neighboring colonies, and within days are treated as part of the new colony.

Army ant colonies are dominated by a single large queen who produces the eggs that become the colony's millions of workers. Colonies quickly disappear when she dies, raising the question of what happens to all those workers.

To investigate this phenomenon, Kronauer and colleagues removed queens from multiple colonies of African army ants, *Dorylus molestus*, on the eastern slopes of Mt. Kenya. Using genetic analysis, the researchers determined that most of the queenless workers simply joined a neighboring colony, slowly losing the distinctive odor of their former colony and becoming fully integrated. The benefits for

the absorbing colony are clear: increased size leads to improved foraging efficiency, competitiveness and reproductive output.

In one queenless colony, however, workers produced a small brood of winged males. The researchers removed these males for analysis, but in an undisturbed colony they would fly off looking for young unmated queens. Although this strategy does provide some chance of passing along the colony's genes, the small number of winged males makes the efficiency of this strategy doubtful. The study was published in *Proceedings of the Royal Society of London*.

Kronauer DJC, Schöning C, d'Ettorre P, Boomsma JJ (2010) Colony fusion and worker reproduction after queen loss in army ants. *Proceedings of the Royal Society B* 277:755-763.



Daniel Kronauer

## Hrды Fellow H. Bradley Shaffer

**H. Bradley Shaffer**, Professor of Evolution and Ecology at the University of California at Davis, was awarded the 2009–2010 Sarah and Daniel Hrdy Fellowship in Conservation Biology from the Department of Organismic and Evolutionary Biology. Prof. Shaffer's work was conducted in the MCZ's herpetology department in association with James Hanken.

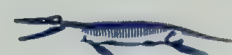
Prof. Shaffer, with the assistance of Harvard undergraduates **Jennifer Woolridge** and **Tucker Pforzheimer**, created micro-CT (computed tomography) scans of more than 250 of the world's 300-plus species of living turtles and tortoises, including 100 species in the MCZ collections. This image database will serve as a resource to study the evolution of shell and skull morphology during the 210 million years of turtle evolution. The database will also be a valuable resource for setting conservation priorities for critically endangered species of turtles and tortoises.

In addition to his research, Prof. Shaffer developed and taught a new undergraduate seminar course, *Conservation Genetics*, in the fall semester. The course examined the ways in which genome-enabled science can be used to guide effective conservation and management of endangered taxa.

On November 5, 2009, Prof. Shaffer delivered the Hrdy Fellowship annual lecture, "Making population biology relevant to conservation: The California Tiger Salamander as a test case." In his lecture, Prof. Shaffer discussed key results of his lab's successful efforts to bring landscape genetics, field ecology, phylogeography and population genetics to bear on achieving listed status for the California tiger salamander under the U.S. Endangered Species Act.



H. Bradley Shaffer and Jennifer Woolridge





## PROJECTS & INITIATIVES

### Encyclopedia of Life (EOL)

#### 2010 EOL Rubenstein Fellows

The 2010 EOL Rubenstein Fellows comprise 17 early-career scientists from institutions around the globe. Through the generosity of David M. Rubenstein, the EOL Rubenstein Fellows program provides part-time funding that enables these scientists to compile authoritative information about biological species and make it freely available to anyone in the world through the EOL website, [eol.org](http://eol.org).

Two of the EOL Fellows are based at the MCZ: **Gisele Kawauchi**, postdoctoral fellow in invertebrate zoology in the Giribet lab, and **Breda Zimkus**, former graduate student in herpetology in the Hanken lab and project manager for the MCZ's new Genetics Resources Facility.

For her Encyclopedia of Life project, Dr. Kawauchi will assemble an online guide for collecting and dissecting Sipuncula, or peanut worms. She also will build pages on EOL for each of the approximate 320 Sipuncula species to facilitate identification and systematic studies of these marine invertebrates. Dr. Zimkus will assemble EOL species pages to assist in the identification and conservation of sub-Saharan amphibians.

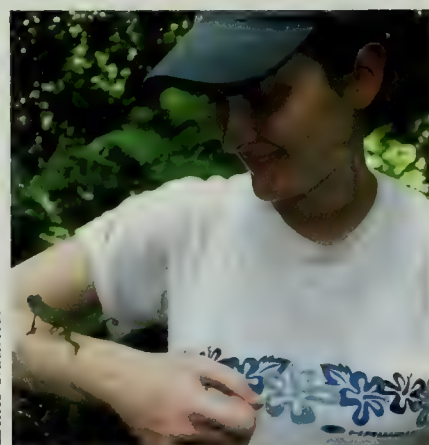
#### Education Lifedesks

Students in Jim Hanken and Jonathan Losos's spring class *OEB 167: Herpetology* and George Lauder's *OEB 130: Patterns & Processes in Fish Diversity* are authoring EOL species pages using Education Lifedesks, an online writing and editing application that was developed by the EOL Learning and Education Group at the MCZ and the EOL Informatics Group at the Marine Biological Laboratory. Students populate species pages with data on behavior, distribution, habitat, morphology and more. The information is then posted for review and editing by their instructors before it is approved and published to EOL. Graduate students **Luke Mahler** in herpetology and **Jeanette Lim** and **Erin Blevins** in ichthyology are overseeing the editing and revision process for their respective classes. **Lee Dieterich '10** will be working as a summer

MCZ-EOL intern to assist Luke Mahler in the review and editing process for herpetology. [www.edulifedesks.org](http://www.edulifedesks.org)



Gisele Kawauchi



Breda Zimkus



Ryan Kerney & Breda Zimkus

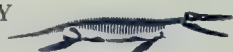


#### EOL Synthesis Meeting on Deep-Sea Fishes

The MCZ hosted an EOL Synthesis Meeting on Deep-Sea Fishes in May 2010. The meeting gathered experts and aspiring deep-sea systematists to catalog the world's deep-sea species and invigorate the pace of discovery in the benthic realm. The meeting produced an annotated inventory of all deep-sea vertebrates, those fishes adapted to life in Earth's most harsh and barren oceanic waters. The inventory will make a major contribution to EOL species pages. [synthesis.eol.org](http://synthesis.eol.org)

#### New Field Guide Tool

EOL's Learning and Education Group, which is based at the MCZ, is developing an online Field Guide Tool that will enable anyone to organize EOL species information for a particular location anywhere on Earth. The field guides will be highly customizable, allowing users to define parameters for species based on personal interests. The group is currently testing various formats and options for electronic field guides and gathering ideas and feedback from the general public. [education.eol.org/ideas/tools/fieldguide](http://education.eol.org/ideas/tools/fieldguide)





## Harvard Museum of Natural History

The Harvard Museum of Natural History opened a new multimedia exhibition in May 2010. **Headgear: The Natural History of Horns and Antlers**, which runs through January 2, 2011, explores fascinating questions about how horns and antlers are formed, how they evolved and how they function. Drawn from the MCZ's remarkable collections, the exhibition features a dramatic array of horns, antlers and head mounts of a wide variety of species. Visitors can touch real specimens, learn about horn-like structures in animals that range from tiny beetles to massive dinosaurs, and view 3D diorama and video presentations that illustrate the use of horns and antlers in combat.

Through the generosity of MCZ Faculty member **Paul Zofnass** '69, M.B.A. '73, as well as other individual donors, HMNH will create **New England Forests: The Zofnass Family Gallery**. Opening in Spring 2011, this permanent multimedia exhibition will utilize research and collections from the MCZ and other parts of the University to explore the natural history, environmental significance, historical development and conservation of New England forests. The exhibition will present the latest research on the role of forests in carbon

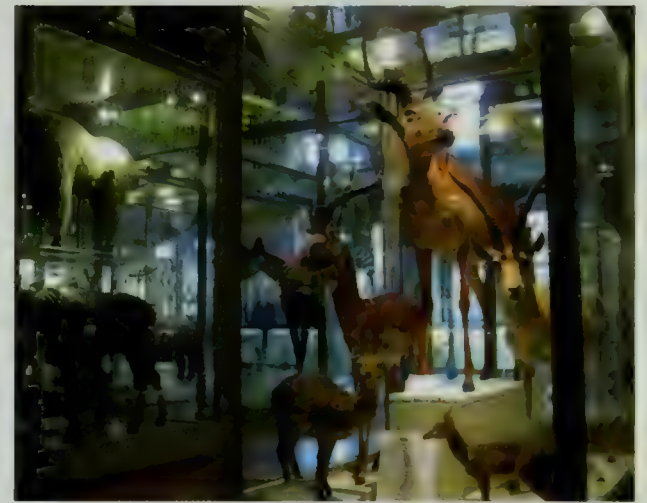
sequestration, address the threats created by invasive species, and demonstrate the methods and tools that scientists use to investigate these issues.

Constructed in 1872, the **Great Mammal Hall** is the oldest and most dramatic public gallery in the Harvard Museum of Natural History. Renovated as part of the MCZ's 150<sup>th</sup> anniversary, the animal mounts were cleaned and the glass display cases were restored to their 19<sup>th</sup>-century colors. A group of undergraduates, supervised by mammal curator **Hopi E. Hoekstra**, reevaluated the taxonomy of the animals and arranged them accordingly. The century-old cases now reflect the most recent advances in our understanding of mammalian relationships, and round red stickers on some of the labels communicate current conservation status, including in some cases "threatened" or "extinct." A video installation, made possible through a donation by Harvard alumnus **John D. Freedman** '84, shows the history of the Great Mammal Hall. The gallery reopened October 16, 2009.



*Headgear: The Natural History of Horns and Antlers*

Catherine Weisel



*The Great Mammal Hall*

## Biodiversity Heritage Library

On June 27, 2010, the Biodiversity Heritage Library (BHL) received the Association for Library Collections & Technical Services **Outstanding Collaboration Citation** at the American Library Association's annual meeting in Washington, D.C. BHL has fulfilled a scholarly need by providing open access to a large body of historical materials on biodiversity within the biological, ecological and environmental sciences. **Joseph deVeer**, Head of Technical Services at the MCZ's Ernst Mayr Library, works with the twelve member institutions to digitize rare collections and artwork. BHL also is a key component of the Encyclopedia of Life, providing online access to more than 31 million pages of digitized biodiversity literature via EOL species pages. [www.biodiversitylibrary.org](http://www.biodiversitylibrary.org)

BHL is going global, with BHL-Europe, BHL-China, and BHL-Australia well underway and preliminary discussions occurring with Bibliotecha Alexandrina for an Arab-language BHL. Staff from BHL, including Ernst Mayr Library's **Connie Rinaldo**, traveled to Vienna in May 2010 to discuss project details and developments with the BHL-Europe team. BHL-Europe is now accessible via Europeana, a virtual European library, which aims to make Europe's cultural and scientific resources accessible for all. [www.europeana.eu](http://www.europeana.eu)





## E.O. Wilson Delivers Prather Lectures

Jon Chase



Edward O. Wilson

**Edward O. Wilson** presented Harvard's annual John M. Prather Lectures in Biology in April 2010, encapsulating his 55-year career at the university and looking forward to the critical challenges ahead. In his first of three lectures, "Biodiversity and the Future of Biology," Prof. Wilson discussed the richness of global biodiversity and the dangers posed by accelerated erosion of ecosystems to support this biodiversity. Prof. Wilson urged greater attention to and examination of the living world, which would open a major new scientific front of biology for the 21<sup>st</sup> century. In his second lecture, "The Superorganism," Wilson used

insect societies to demonstrate evolution from single organisms to the ecological dominance of the superorganism. Understanding the transitions between different levels of biological organization provides insight into how major steps of evolution can occur. In his final lecture, "Consilience," Prof. Wilson explored the boundaries among science, social sciences and the humanities and the interlocking cause and effect of these disciplines. This borderland of previously poorly understood relationships is the new frontier of academia, providing opportunities for novel collaboration across three great branches of learning.

Prof. Wilson's lectures are available online at [www.oeb.harvard.edu/news\\_events/news\\_items/prather\\_2010.html](http://www.oeb.harvard.edu/news_events/news_items/prather_2010.html).

## The MCZ Commemorates 150 Years



Louis Agassiz

In celebration of the 150<sup>th</sup> anniversary of the Museum of Comparative Zoology, a series of three lectures were given by Director **James Hanken**; Dr. Cristián Samper, Director of the Smithsonian Institution's National Museum of Natural History; and Dr. Michael Novacek, American Museum of Natural History paleontologist and Senior Vice-President and Provost of Science. Dr. Hanken gave the first address, "This Brick Ark: Celebrating the Museum of Comparative Zoology's First 150 Years and the Beginning of the Next 150." Hanken traced the founding of the MCZ and its legacy as a leader in the field of natural history research and education. In his lecture "Natural History Museums and Society," Dr. Samper examined the past, present and future of natural history collections. Modern museums are increasingly focusing on their

roles to educate and inform the public, attracting visitors to the physical spaces with sophisticated interactive exhibitions and engaging them on the Internet with online exhibitions and digitized collections. Dr. Novacek also stressed the importance of education in his talk, "Natural History Museums in the Environmental Century." Because scientific realities are not generally understood by the general public—decoupling climate change and biodiversity loss, for example—researchers and the museums that house them must highlight the relevance of their work as they seek to understand the intricacies of the natural world.

Dr. Hanken and Dr. Samper's lectures are available online at [www.hmnh.harvard.edu/lectures-classes-events/videos.html](http://www.hmnh.harvard.edu/lectures-classes-events/videos.html).

### MCZ History: William James

The MCZ has attracted more than its fair share of talented students, a tradition that continues to this day. Among them is William James, founder of American psychology and renowned philosopher. As a Harvard undergraduate James came under the spell of Louis Agassiz, who brought him along on the MCZ's Thayer expedition to Brazil in 1865–1866. James quickly discovered that serious field biology, and especially gathering specimens, was not to his liking. As he wrote to his parents in a letter from October 1865: "If there is any thing I hate it is collecting. I don't think it is suited to my genius at all."



William James, taken in Brazil in 1865 following an attack of smallpox

Courtesy Houghton Library





# AWARDS & RECOGNITION



Catherine Weisel

## Farish A. Jenkins, Jr.

The 2009 Romer-Simpson Medal was awarded to Farish A. Jenkins, Jr., at the 69<sup>th</sup> annual meeting of the Society of Vertebrate Paleontology in Bristol, UK. This award is SVP's highest honor, bestowed for sustained and outstanding scholarly excellence in the discipline of vertebrate paleontology.

Prof. Jenkins also was recognized with a 2010 Everett Mendelsohn Excellence in Mentoring Award, established by the Harvard Graduate Student Council to honor faculty members who truly go out of their way to mentor Graduate School of Arts and Sciences students. Finally, Prof. Jenkins received The Joseph R. Levenson Memorial Teaching Prize, 2010, given by undergraduate students to professors whose excellence in teaching has made a difference in their Harvard experience.

## Breda Zimkus

Breda Zimkus received the Ethel K. Allen Fellowship from Sigma Delta Epsilon-Graduate Women in Science, an award that is designed to encourage research careers in the sciences by women. Zimkus is a former graduate student in herpetology in the Hanken lab and is currently project manager for the MCZ's new Genetic Resources Facility. Her fellowship will be used to support her postdoctoral work on the frog genus *Ptychocheilus*.

## Edward O. Wilson

In October 2009, the Prince Albert II of Monaco Foundation honored Edward O. Wilson with the prestigious Biodiversity Award for his lifelong contribution to protecting the world's biological diversity. During his acceptance of the award, Dr. Wilson stressed that we have only just begun to explore Earth's biodiversity.



Prince Albert II of Monaco and Edward O. Wilson

## James J. McCarthy

The University of California, San Diego, named James J. McCarthy one of the University's Top 100 Prominent and Influential Alumni. In May 2010, Prof. McCarthy received an honorary degree from Bates College in Maine.

## Krzysztof M. Kozak

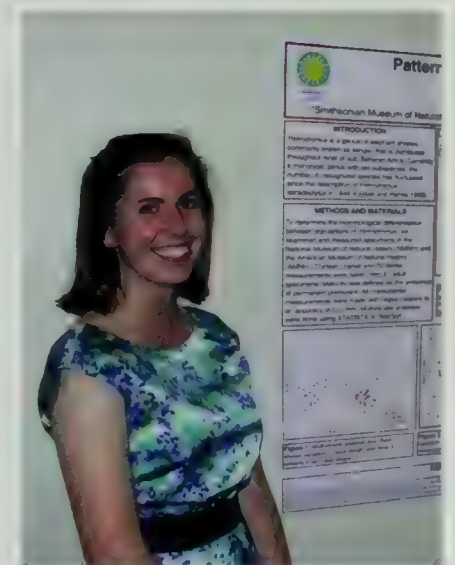
Krzysztof M. Kozak, an undergraduate in the Hoekstra lab, was awarded a Hoopes Prize for his senior honors thesis, "Tales of tails: Multiple origins of adaptive tail elongation in the deer mouse, *Peromyscus maniculatus*." His thesis work was supported by several Grants-In-Aid of Undergraduate Research from the MCZ.

## Joanna Larson

Joanna Larson, an undergraduate in the Hanken lab, received a summer fellowship from the Smithsonian's National Museum of Natural History. Larson interned in the NMNH Department of Vertebrate Zoology, studying patterns of morphological variation in elephant shrews and morphological features of hybrids of polar bears and brown bears.

## Prashant Sharma

Prashant Sharma, a graduate student in invertebrate zoology and member of the Giribet lab, won the Willi Hennig Award for best oral presentation by a student at the Hennig Society's annual meeting in Honolulu, Hawaii, in May 2010.



Joanna Larson





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# MCZ GRANT RECIPIENTS

## ACADEMIC YEAR 2009–2010

### Grants-In-Aid of Undergraduate Research (GUR)

These grants support research by Harvard undergraduates under faculty supervision. Priority is given to projects that utilize MCZ research collections, laboratories and facilities. Support for these grants comes from the Myvanwy M. and George M. Dick Scholarship for Students.

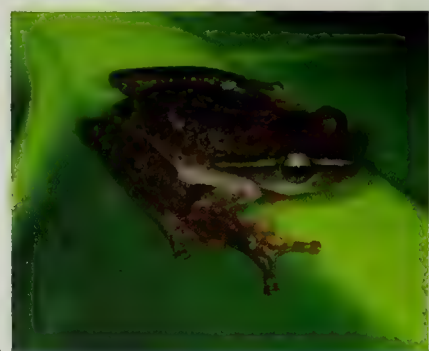
Recipient	Faculty Sponsor	Project Title	Amount
Andrew G. Brownjohn	Naomi E. Pierce	Determining the cytological mechanism of parthenogenesis in <i>Cerapachys biroi</i>	\$2,160
Elena Butler	Charles C. Davis	Applied pitcher plants: using phylogeny to understand biogeography	\$2,469
Eva Catenaccio	Hopi E. Hoekstra & Jonathan Losos	The genetic basis of body coloration in <i>Anolis</i> lizards: the <i>MC1R</i> gene and interspecific patterns of variation	\$2,000
Grace K. Charles	Jonathan B. Losos	Interactive effects of species loss and climatic variability: an experimental approach	\$2,500
Andrew H. Chen	N. Michele Holbrook	The invasive species ecology of <i>Myoporum laetum</i>	\$2,500
Jeremy L. Hsu	Marcus Kronforst	Examining the genetic basis of migration in monarch butterflies	\$2,200
Alexander M. Kim	Gonzalo Giribet	Anomalous distributions and invasion in Texan freshwater prawns (Decapoda: Caridea: <i>Macrobrachium</i> )	\$840.80
Joanna Larson	James Hanken	Identification of African tadpoles using DNA-barcoding	\$2,401
Sondra Lavigne	Charles C. Davis	The breeding system and extent of post-parasite infection in a <i>Rhizanphes lowii</i> population	\$2,481
Jennifer Levye	N. Michele Holbrook	Water usage in Melastomataceae along a successional gradient	\$2,500
Daniel P. Perl	Daniel E. Lieberman	An energetic comparison of shod running vs. barefoot running	\$1,500
Carl T. Pforzheimer	H. Bradley Shaffer	Multivariate analysis of turtle shell evolution	\$2,400
Megan E. Popkin	Naomi E. Pierce	Determining the purpose of stridulation in <i>Lycaena phlaeas americana</i>	\$2,500
Brandon Kwee Boon Seah	Colleen M. Cavanaugh	Co-speciation and phylogeny in a three-way marine symbiosis	\$2,500
Susan Seav	Arkhat Abzhanov	The developmental bases of sexual shape dimorphism in anole lizards	\$2,230 Fall; \$2,470 Winter
Trieu H. Ton	Cassandra G. Extavour	Analysis of <i>Parhyale hawaiiensis</i> maternal determinants and germ cell differentiation	\$1,200
Lewis M. Ward	Christopher J. Marx	Who eats what, where and why? Characterization of carbon source utilization by multiple strains of methylobacterium	\$1,850
Jennifer Woolridge	H. Bradley Shaffer	Broad-scale turtle morphometric study using MCZ collections	\$2,400
Chung Yao Yu	Peter R. Girguis	Effects of symbiont composition on the metabolism of "short-fat" and "long-skinny" <i>Ridgeia piscesae</i>	\$2,500 Fall; \$2,000 Winter
		<b>Total Awards</b>	<b>\$45,601.80</b>



Collin Johnson



Adrea Gonzales-Karlsson



Joanna Larson





## Putnam Expedition Grants

Putnam Expedition Grants are intended to support MCZ faculty-curators, postdoctoral fellows and graduate students in collecting specimens and data relating to the study of comparative zoology. Priority is given to projects that collect living specimens in regions where habitats are threatened or fossil specimens in regions most likely to hold important clues for unraveling evolutionary strategies.

Recipient	MCZ Department	Project Title	Amount
Ronald Clouse & Prashant Sharma	Invertebrate Zoology	Collecting harvestmen (Stylocellidae and Zalmoxidae, Opiliones) from Micronesia and Palawan Island, Philippines	\$8,440
Matthew Fujita	Ornithology	Contact zone dynamics and systematics of a widespread Australian endemic gecko	\$4,700
Vanessa Gonzalez	Invertebrate Zoology	Collecting members of Archiheterodonta (Bivalvia: Heterodonta) in the western North America: Resolving familial relationships within this group	\$5,800
Milan Janda	Entomology	Ant communities of New Guinea savannas—the first exploration of unknown fauna	\$9,750
Zofia Ada Kaliszewska	Entomology	Lycaenid life history evolution in South Africa	\$9,175
Emily Kay	Mammalogy	Sexual isolation as a reproductive barrier between <i>Peromyscus leucopus</i> and <i>P. gossypinus</i>	\$7,610
Sarah Kocher & Naomi Pierce	Entomology	Expedition to collect <i>Lasioglossum albipes</i> (Hymenoptera: Halictidae): a socially polymorphic halictid bee species in the Palearctic	\$8,214
Clemens Küpper	Ornithology	Evolution of sex-role reversal in polygamous shorebird	\$4,297
Frank E. Rheindt	Ornithology	Examining introgression between two species of <i>Elaenia</i> flycatcher	\$5,867
Wenfei Tong	Mammalogy	Geographic variation in kinship and cooperation in wild mound-building mice ( <i>Mus spicilegus</i> )	\$5,000
Sebastián Vélez	Invertebrate Zoology	Deep sampling of the New Zealand Triaenonychidae (Opiliones, Laniatores) to finalize a biogeographical study and revision of the genus <i>Nuncia</i>	\$6,000
		<b>Total Awards</b>	<b>\$79,753</b>



Jon Sanders



Gabriel Miller



Clemens Küpper

## Miyata Grants

Miyata Grants are intended to enable herpetological fieldwork by MCZ graduate students. Non-herpetological fieldwork may be eligible when there are no deserving herpetological projects.

Recipient	MCZ Department	Project Title	Amount
Shane Campbell-Staton	Herpetology	Adaptive response to pathogen infection: <i>Anolis carolinensis</i> and <i>Plasmodium floridense</i>	\$4,337
Yoel Stuart	Herpetology	Ecological character displacement in <i>Anolis carolinensis</i>	\$7,205
Yunke Wu	Herpetology	Systematics, phylogeography and ecology of Eastern Asian salamanders in the genera of <i>Pachytriton</i> , <i>Paramesotriton</i> and <i>Cynops</i>	\$3,000
		<b>Total Awards</b>	<b>\$14,542</b>



Clemens Küpper





Ernst Mayr Travel Grants in Animal Systematics

Ernst Mayr Grants support travel for research in animal systematics and are open to the scientific community worldwide. The principal objective of these grants is to stimulate taxonomic work on neglected taxa and/or poorly described species. Ernst Mayr Grants typically facilitate visits to institutional collections, with preference given to research using the MCZ's collections.

Recipient	Institutional Affiliation	Project Title	Amount
Rachel J. Arnold	University of Washington	A phylogenetic analysis and taxonomic revision of the stargazers (Teleostei: Uranoscopidae)	\$1,500
Corinna S. Bazelet	Stellenbosch University, South Africa	A review of the South African agile grasshoppers (Insecta: Orthoptera: Acrididae: Euryphyminae) and a revision of the genus <i>Euryphymus</i> Stål, 1873	\$800
Marek L. Borowiec	University of Wroclaw, Poland	Taxonomy and systematics of the ant subfamily Cerapachyinae (Hymenoptera: Formicidae)	\$1,300
Michael G. Branstetter	University of California, Davis	Taxonomic revision of Mesoamerican <i>Stenamma</i> (Hymenoptera: Formicidae)	\$1,180
Kirstin Sara Brink	University of Toronto	Evolutionary history of <i>Dimetrodon</i>	\$1,000
Shawn T. Dash	University of Texas at El Paso	A taxonomic revision and sytematic treatment of <i>Hypoponera</i> (Hymenoptera: Formicidae) Santschi, 1938 of the New World	\$1,484
Leandro Carlos Gaetano	Universidad de Buenos Aires, Argentina	Restudy of the basal mammals and cynodont collections of the MCZ, comparative anatomy and phylogeny	\$950
Luiz Fernando Gelin	University of Vermont	Taxonomy of <i>Polybia</i> Lepeletier, 1836 (Hymenoptera, Vespidae, Polistinae)	\$1,100
Geert Goemans	University of Connecticut	Revision of the South American cicada tribe Zammarini (Auchenorrhyncha, Cicadidae)	\$1,000
Liza E. Gomez Daglio	University of California, Merced	Taxonomic revision of scyphozoan jellyfish	\$1,300
Jesús Gómez-Zurita	Spanish High Research Council, Institute for Evolutionary Biology	Systematic revision of the poorly studied southern nearctic and neotropical <i>Calligrapha</i> Chevrolat	\$800
Jessica R. Hawthorn	University of Toronto	Evolution and systematics of Ophiacodontidae	\$1,000

Jon Sanders



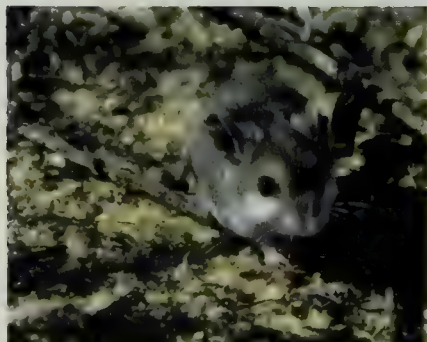
James Onstad



Jessica Hawthorn



Kevin Lin



Samson Kurukura

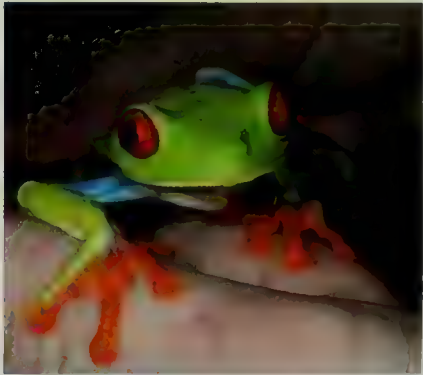




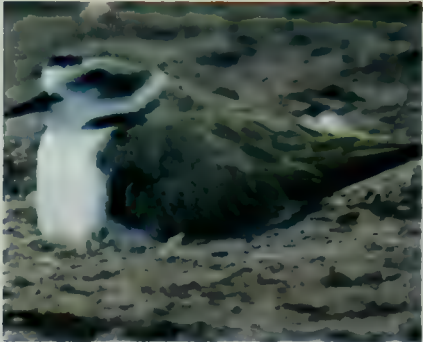
Recipient	Institutional Affiliation	Project Title	Amount
Adelita Maria Linzmeier	Universidade Federal do Paraná, Brazil	Study of <i>Monoplatina</i> (Coleoptera, Chrysomelidae, Alticini) types in the Natural History Museum, London	\$1,500
Paulo Lucinda	University of Michigan, Museum of Zoology	Systematics and biogeography of the live-bearing killifishes of the tribes Priapichthyni and Girardinini (Cyprinodontiformes, Poeciliidae, Poeciliinae)	\$1,000
William P. Mackay	University of Texas at El Paso	Revision of the New World species of the ant genus <i>Aphaenogaster</i>	\$1,500
François Michonneau	University of Florida	Redefining species limits in the complex <i>Holothuria impatiens</i>	\$1,000
Jesús Orozco	University of Nebraska	Revision of the American Cetoniini (Coleoptera: Scarabaeidae: Cetoniinae)	\$1,500
Claudia M. Ortiz-Sepúlveda	Universidad Nacional de Colombia	Revision of the ant genus <i>Brachymyrmex</i> Mayr (Formicidae: Formicinae)	\$1,500
Jong-Seok Park	Louisiana State University	A generic revision of the supertribe Faronitae (Coleoptera: Staphylinidae: Pselaphinae) and a revision of the genus <i>Sagola</i> (Staphylinidae: Pselaphinae: Faronitae)	\$1,500
María del Rosario Robles	Universidad Nacional de La Plata, Argentina	Study of Syphaciini and Capillariinae nematode parasites from American rodents: morphology and taxonomy	\$1,500
Clare H. Scott	University of Florida	Revision and review of the generic limits of the lichen moth genus <i>Lycomorpha</i> (Lepidoptera: Noctuidae: Arctiinae)	\$1,500
Cameron D. Siler	University of Kansas	Historical processes of limb reduction and loss in an island skink lineage	\$835
Kelly M. Walsh	San Francisco State University and the California Academy of Sciences	Systematics of <i>Echinocyamus</i> (Fibulariidae: Clypeasteroidea)	\$1,350
		<b>Total Awards</b>	<b>\$28,099</b>



Jessica Hawthorn



Luke Mahler



Clemens Küpper



Jessica Hawthorn



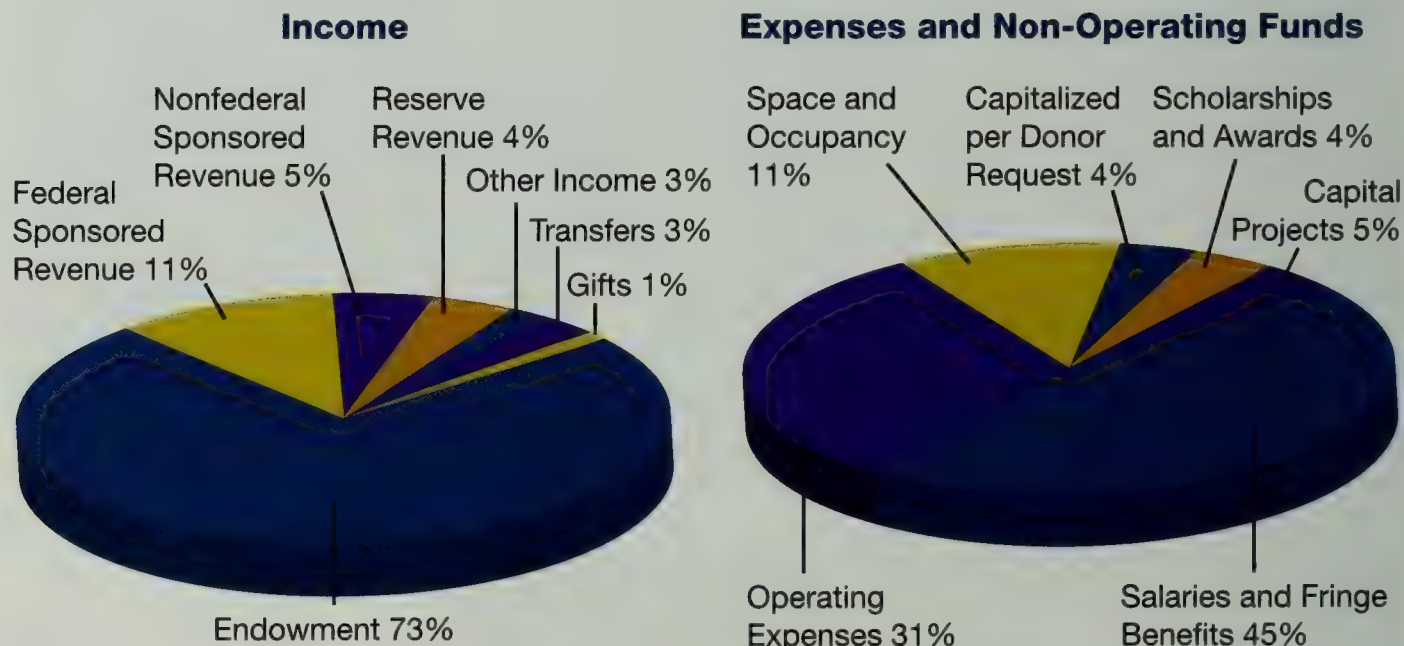
Gabriel Miller





# FINANCIAL DATA

These charts describe the income and expenses of the Museum of Comparative Zoology in fiscal year 2010. Endowment income funds much of the Museum's activities, including acquisition and maintenance of collections, faculty and staff salaries, capital projects, facilities renovation and maintenance. Transfers include Harvard University-funded faculty research and financial support for the Ernst Mayr Library. Other Income comprises miscellaneous income from publication subscriptions, royalties, sales and fees, revenue generated from assets purchased through endowments and endowed funds decapitalized per donor request. Capital Projects includes renovation of the MCZ's ground floor for alcohol-based collections. Building expenses such as maintenance, facility improvements and utilities are captured in the Space and Occupancy category. Operating Expenses consist of equipment purchases, supplies, consultant and conferences fees, as well as annual subventions to the Department of Organismic and Evolutionary Biology (OEB) and to the Harvard Museum of Natural History for general support, gallery installation and renovations. Support for MCZ-affiliated graduate students in OEB is included in Scholarships and Awards.



Income		Expenses	
Endowment	\$12,587,266	Salaries and Fringe Benefits	\$7,803,399
Federal Sponsored Revenue	\$1,906,559	Operating Expenses	\$5,273,427
Nonfederal Sponsored Revenue	\$908,014	Space and Occupancy	\$1,971,460
Reserve Revenue	\$609,830	Capital Projects	\$770,679
Transfers	\$579,737	Capitalized per Donor Request	\$714,294
Other Income	\$396,010	Scholarships and Awards	\$646,035
Gifts	\$191,878		
<b>Total</b>	<b>\$17,179,294</b>	<b>Total</b>	<b>\$17,179,294</b>





## Faculty-Curators

Andrew A. Biewener  
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Chair, OEB*

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*John L. Loeb Associate Professor of  
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Vertebrate Paleontology*

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Curator of Ichthyology*

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Alexander Agassiz Professor of  
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Curator of Malacology*

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Marine Invertebrates*

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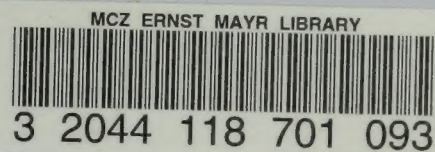
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### MCZ Faculty

The MCZ's charter, signed in 1859, mandates that the Museum's activities will be overseen by a governing board, the Faculty of the Museum of Comparative Zoology.

The members of the Faculty are:

Dr. John D. Constable  
Mr. Robert G. Goelet  
Mr. George Putnam, Jr.  
Mr. George Putnam, III  
Mr. David B. Stone  
Dr. Barbara Jil Wu  
Mr. Paul J. Zofnass  
President Drew Gilpin Faust

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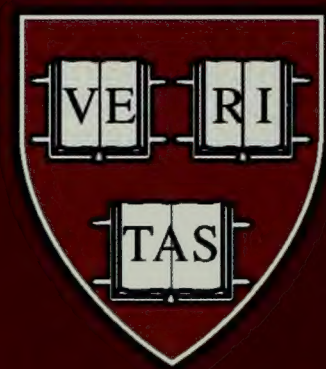
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